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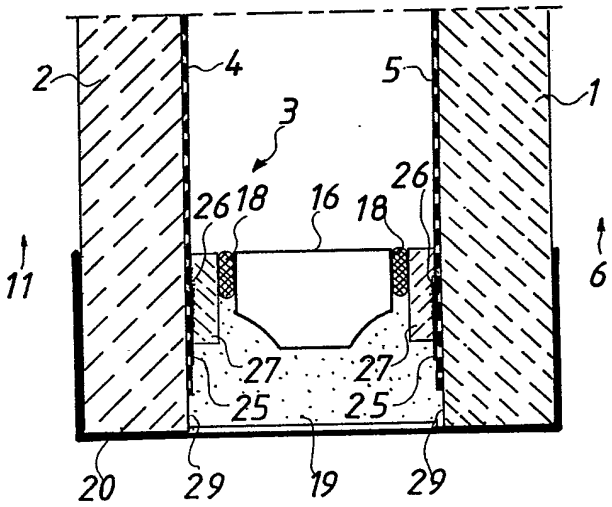
(54) **Transparent heat radiation panel based on glass.**

(57) Transparent heat radiation panel based on glass, comprising one or more sheets of glass which are arranged parallel to each other and at least one glass surface of which is provided with a thin metal layer which is disposed in an electric circuit and is heated by the Joule effect, characterized by a second metal layer (5) disposed between the heated metal layer (4) and one of the adjacent areas, a screen (23), the contact strip consisting of an adhesive tape (25), the insulating strips (27) between a metal layer and the intermediate section (16), and by the electric power supplied.

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"Transparent heat radiation panel based on glass".

The present invention relates to a construction of two or more sheets of glass which are arranged parallel to each other, for windows and/or other glass surfaces, on one or more of their surfaces provided with an extremely thin metal layer, at least one of which is disposed in an electric circuit, so that through correct disposition within the construction and through control of the power supplied, heat radiation takes place over the surface of said construction on one or both sides.

Such a transparent heat radiation panel is suitable for an enormously wide range of applications. Such applications can be broken down roughly into a number of groups. A first application group is that where the panel separates two environments from each other and improves the heat comfort of one of those environments. In a second application group it is important for the panel itself to have on one or both sides a temperature which is higher than that of the outside environment.

Falling within that first application group is, for example, the use of the transparent heat radiation panel as double or triple window glazing for buildings. Through their action, the windows, which traditionally act as cold surfaces and thus give rise to heat losses, contribute substantially to the improvement of heat comfort in a building or room. If there is sufficient glass surface in a room, the glazing can even act as the sole heat source.

The principle of such glazing is known : an extremely thin, and therefore transparent, metal layer is provided on one of the surfaces of one of the glass panels of a glazing unit. If this metal layer is incorporated in an electric circuit, its low thickness causes it to act as a resistor and thus to heat up due to the

Joule effect. However, the known glazing units produced for this purpose still give too low an output to be able to compete with classic heating installations such as e.g. central heating with heating oil or gas as the fuel, electric heating with heat accumulation elements etc. Electricity consumption is much too high, on the one hand, and the losses of the heat generated in the glazing to the outside environment are too great, on the other.

An object of the invention is to produce a heat radiation panel which has a sufficiently high output for it to be used in the form of window glazing as an additional or the sole heat source for a room.

The present invention, a transparent heat radiation panel, comprising several sheets of glass, at least one glass surface of which is provided with a thin heated metal layer which is disposed in an electric circuit and is heated up by the Joule effect, is characterized by the electric power supplied to the heated metal layer in such a way that the temperature of said metal layer is between 20 and 70 deg.C, and is such that heat radiation is released at the external surfaces of the heat radiation panel.

The power supplied to the heated metal layer is, in other words, insufficient, through heat conduction through the section of the sheet of glass, to cause heat emission by convection at the external surfaces of the heat radiation panel. At these temperatures the metal layer does, however, continue to give off a large quantity of heat in the form of radiation. This heat radiation leaves partially through the glass sheet carrying the metal layer to the one adjacent area and leaves partially to the other adjacent area.

The heat radiation panel thus radiates over its surfaces electromagnetic rays, with a wavelength of 3 to 10 microns, so that a person in the radiation area

experiences a sensation of warmth.

The transparent heat radiation panel according to the invention is further characterized by a second metal layer between the heated metal layer and one of the adjacent areas.

This second metal layer thereby acts as a reflecting layer which reflects the heat radiation generated by the heated metal layer and directed towards said second metal layer. The part of the heat radiation which is generated by the heated metal layer and which faces away from the glass surface bearing the heated metal layer is thus reflected and joins the heat radiation which is directed through the glass sheet bearing the heated metal layer. The end result is that practically all heat radiation is released at the same external surface of the heat radiation panel.

This heat radiation panel is suitable for a wide range of applications.

The most obvious application is that in which the present invention is used in the form of double or triple glass as window glazing. Provided that there is a sufficiently large glass surface, this construction can fully or partially ensure an increase in or maintenance of the thermal comfort of an interior environment.

Even at the relatively low maximum temperature to which the heated metal layer of the transparent heat radiation panel is heated, there is a small risk of the metal layers being broken off. In the arrangement in which the heated metal layer and the reflecting metal layer face each other with their free surface and have only the cavity filled with air or with some other suitable gas between them, a relatively strong electric field occurs between the two metal layers as a result of their potential difference, and the two layers can act as cathode and anode with an exchange of free electrons. In other words,

the layers exhaust each other and in the long run can be destroyed, partly under the influence of temperature.

Aluminium, the material generally used for the intermediate sections in the construction of double or triple insulating glazing, also produces a number of problems. If the heated, current-carrying metal layer and the reflecting, non-current-carrying metal layer are facing each other with their free surface, the aluminium produces direct electrical contact between the current-carrying and the non-current-carrying layer. This should, of course, be avoided.

Another object of the invention is to produce a heat radiation panel which also provides a solution to these problems.

The heat radiation panel according to the invention, comprising several sheets of glass, at least one glass surface of which is provided with a thin heated metal layer which is disposed in an electric circuit and is heated up by the Joule effect, and a second metal layer disposed against another glass surface between the heated metal layer and the outside environment, is characterized by an insulating screen, preferably made of glass, which is disposed between the two metal layers.

Another feature of the heat radiation panel according to the invention, which is built up in the form of several glass sheets held apart by intermediate sections running along their edges, is that at least the glass surface carrying the heated metal layer, and possibly also the other glass surfaces carrying a metal layer, have stuck onto them all the way round a thin insulation strip, close to their edge, at the level of the point where the section goes when the sheets of glass are being put together.

Another object of the invention is to provide a contact strip which can be fitted in a simple and rela-

tively cheap way on two opposite edges of the heated metal layer, in such a way that said metal layer can be fitted in an electric circuit.

The heat radiation panel according to the invention, which is provided with a contact strip over the length of two opposite sides of the heated metal layer, is characterized by the contact strip which consists of an adhesive tape made of electrically conducting material, finished with a baked-in silver layer running over one or both edges of the adhesive tape from the top surface of the adhesive tape to the top surface of the heated metal layer.

The embodiment of the heat radiation panel according to the invention discussed so far, namely the double or triple glazing, belongs to the earlier-mentioned first application group. The advantages of a heating unit made up of this heat radiation glazing are obvious. First and foremost, there are aesthetic advantages : the rooms to be heated are no longer disfigured by space-requiring heating elements such as cast iron radiators or electric heating elements. On the other hand, the heating comfort in a room is improved by the elimination of the cold surfaces and by converting these to heat surfaces.

Another application of the heat radiation panel according to the invention within the same first application group is that in which several heat radiation panels are used to construct an aquarium or terrarium. Here again, the advantages are obvious. In the case of an aquarium, for example, the water is heated up equally, no ugly heating elements need be placed in the water, and there are no safety problems like those found with the classic water heating systems.

An example of the above-mentioned second application group is that where the heat radiation panel according to the invention is set up in front of, behind or around

a mirror glass. Such a mirror hung in a bathroom, due to its temperature being higher than the bathroom environment, will not become steamed up when the bathroom air contains a high level of moisture. Such a mirror can, however, also act as a heat source.

Another example from the second application group is that where the heat radiation panel according to the invention is used as the glazing of, for example, a traffic control tower. By directing outwards all or part of the heat radiation, one prevents those windows from, for example, freezing or steaming up, so that seeing out of them is ensured in all weather conditions.

As examples without any limiting character, there follows below a detailed description of a number of embodiments of the heat radiation panel according to the invention, to indicate further features and advantages of the invention. This description refers to the attached figures, in which :

Fig. 1 is a schematic cross section of a heat radiation panel according to the invention, in the form of double glazing.

Fig. 2 is a schematic cross section of a heat radiation panel according to the invention, in the form of double glazing provided with a screen.

Fig. 3 is a schematic cross section of a heat radiation panel according to the invention, in the form of triple glazing.

Fig. 4 is a schematic cross section of a heat radiation panel according to the invention which releases equal radiation on both sides.

Fig. 5 is a schematic cross section of a heat radiation panel according to the invention which is processed as a mirror.

Fig. 6 is a schematic cross section of a heat radiation panel according to the invention which is pro-

cessed in another construction to a mirror.

Fig. 7 is a dismantled, schematic perspective view of a corner of the glass sheet bearing the heated metal layer.

Fig. 8 is a schematic cross section of an edge of a heat radiation panel according to the invention designed as double glazing, without screen.

Fig. 9 is a dismantled, schematic perspective view of part of the edge of the glass sheet bearing the heated metal layer, with a screen on it.

A first embodiment of the heat radiation panel according to the invention is shown in Fig. 1. Double glazing separating an interior environment (11) from an exterior environment (6) is produced on the basis of two sheets of glass (1) and (2) which are disposed parallel to each other and which have a cavity (3) between them. The inner glass sheet (2) bears the heated metal layer (4), the outer sheet (1) bears the reflecting metal layer (5).

A first possibility for incorporation of the heat radiation panel according to the invention in triple glazing is to set up a third glass sheet parallel to the outermost glass sheet (1) of the double glazing, with between them again a sealed cavity.

Another feature of the heat radiation panel according to the invention is that disposed between the two metal layers is a screen which acts as a dielectric. Said screen is preferably a glass sheet (23) which in the case of double glazing separating an exterior environment (6) from an interior environment (11) (Fig. 2) is placed in the cavity (3) against the free surface of the heated metal layer (4). The glass sheet (23) screens off the free surface of the heated metal layer (4) in insulating fashion and thus prevents the exchange of free electrons between the heated and the reflecting metal layers

(4) and (5). Said glass sheet (23) also acts as an additional cooling element which, together with the innermost glass sheet (2), absorbs the heat of the heated metal layer and thus prevents the temperature of the cavity from rising too high. The glass sheet (23) can be fixed against the innermost glass sheet (2) with a known tranparent adhesive or with the known systems of lamination.

This construction can also be useful for increasing the glass thickness of a glass wall. This can be beneficial, for example, for those faces of aquaria and terraria which have to resist to a great pressure. Since glass provided with a metal layer is available only in limited thicknesses, a thick glass sheet can be stuck to one of the glass sheets bearing a metal layer, in order to increase the strength of the whole construction.

In a second possibility for incorporating the radiation panel according to the invention in triple glazing, the additional glass sheet can be avoided by the following construction. The heated metal layer (4) (Fig. 3) rests on the outside of the innermost glass sheet (2), then followed by - towards the outside - the first cavity (3) and the middle glass sheet (24) which on its outside bears the reflecting metal layer (5). This is then followed by the second cavity (3) and the outermost glass sheet (1). The middle glass sheet (24) acts in this construction as a screen and as a carrier of the reflecting metal layer (5). The reflecting metal layer (5) can also be set up against the inner surface of the outermost glass sheet.

Fig. 4 shows an arrangement which emits equal radiation on both sides. A second glass sheet (32) is indissolubly joined to the bearing glass sheet (8) with the heated metal layer (4) by means of a known, transparent adhesive or by the known systems of lamination. This composition will be used in arrangements where this is necessary for safety reasons.

Another possible arrangement of the radiation panel according to the invention is that in which the panel is incorporated in a mirror (Figs. 5 and 6). A glass sheet (8) with a heated metal layer (4) is either placed against or in front of a mirror glass (33) (Fig. 5), or the mirror glass (33) is placed behind and against a glass sheet (8) with a reflecting metal layer (5), with in front of it - with a cavity (3) between - the glass sheet (8) bearing the metal layer (4) (Fig. 6).

In order that the heated metal layer can be incorporated in an electric circuit, said metal layer, or the bearing glass sheet, must be provided with a contact strip over the length of two opposite sides. Said contact strips permit contact with one or more current-carrying cables, on the one hand, and distribute the current over the length of the heated metal layer, on the other.

Said contact strip (Fig. 7) comprises an adhesive tape (25), made of an electrically conducting material, which is glued and pressed onto the heated metal layer (4) along the edge of the bearing glass sheet (8). The contact strip is finished with a baked-in silver paste layer (26) on one or both of its longest edges. This silver paste layer (26) is spread out over the edge of the adhesive tape (25) up to the heated metal layer and is then baked in, so that the silver diffuses both in the metal of the adhesive tape (25) and in the metal layer (4), and thereby increases the electrical contact between the two metals. In Fig. 7 one silver paste layer (26) is shown by a solid line, and the possible second silver paste layer (26) is shown by a dotted line.

There remains the problem of the intermediate sections which in the construction of double or triple glass hold the glass sheets apart at their edges, form the side limit of the enclosed cavities and, together

with elastic sealing means, ensure that said cavity is held hermetically sealed. The material which is most suitable for these intermediate sections is aluminium, but it is electrically conducting. The elastic sealing means which are provided between the intermediate section and the glass surface do not guarantee absolute electrical insulation, so that if aluminium is used for the intermediate sections of heat radiation panels according to the invention, electrical contact between the heated, current-carrying metal layer and the reflecting metal layer is not ruled out.

For that reason the heat radiation panel according to the invention is provided, at least over the full lengths of the edges of the glass sheet bearing the heated metal layer, and possibly over those of the glass sheet bearing the reflecting metal layer - at least if it is facing the heated metal layer - with a narrow glass strip (27) (Fig. 7) stuck against the glass sheet. Along the edges with a contact strip this glass strip (27) partially covers the adhesive tape (25) and leaves its free over a short distance of its width on the outside of the frame which the glass strips (27) form together. Along the edges without contact strip the glass strip (27) is glued directly to the heated metal layer. In the corners (28) the glass strips (27) join together perfectly, so that they form a frame all the way round, a certain distance away from the edge of the glass sheet.

For a close-fitting construction of the edges of the heat radiation panels, which is produced in the form of double or triple glazing, or in any other form with a cavity which is to be hermetically sealed, the metal layer must be removed over a strip (29) along the edge of the glass sheet (8) (Fig. 7), in order to permit direct adhesion of the elastic sealing means to the glass.

One edge of a heat radiation panel according

to the invention designed as double glazing, without screen, then looks, for example, as follows (Fig. 8). The glazing separates an interior environment (11) from an exterior environment (6) and comprises from inside to outside the innermost glass sheet (2), the heated metal layer (4), the cavity (3), the reflecting metal layer (5), and the outermost glass sheet (1). The adhesive tape (25) is stuck onto the heated metal layer (4). Diffused in over the top edge of said adhesive tape (25) is a silver layer (26). The continuous glass strip (27) is stuck against one or both - here on both - of the glass sheet (2) and (1), against the inside at the same height. The aluminium intermediate section (16) goes between these glass strips (27). Between the side edge of the intermediate section (16) and the glass strip (27) there is a sealing plug (18). Under the sealing plug (18) and the intermediate section (16) the cavity is filled with a sealing agent (19). Underneath the glass sheets (2) and (1), the metal layer is removed over a strip (29), so that the sealing agent (19) comes into direct contact there with the glass. The whole construction is finished with an aluminium clamping section (20) which encloses the two glass sheets (2) and (1) all the way round along the edges.

It goes without saying that when the heated metal layer (4) is covered with a screen (23) (Fig. 2), no glass strip (27) is needed on that side of the cavity (3) (Fig. 8) as an insulator between the metal layer (4) and the intermediate section (16), since said intermediate section then rests against said screen.

In the heat radiation panel according to the invention the use of aluminium for the intermediate sections is thus still possible, and this gives the advantage that this intermediate section, which is electrically conducting, can be earthed for safety reasons.

The contact on the contact strip can be made in the classic way by soldering on of the end of one or more electric cables. With the current glass measurements one contact point per contact strip is sufficient. In the case of the construction with the glass strips (27) (Fig. 7) they must be provided with a recess (30) at the place where the contact point (22) goes, so that here would be sufficient space to solder the end of the electric cable (21) onto the adhesive tape (25).

Another possibility for making the contact on the contact strip is proposed in Fig. 9. The part of the adhesive tape (25) projecting from under the screen (23) is rolled round a copper cable (21), running over the entire or part of the length of the adhesive tape (25). This means that no heat treatment is needed to obtain the contact points. The whole unit may be finished with a non-conducting cover (31). It goes without saying that this form of contact is also possible in the case of the glass strips (27) (Fig. 8).

It is clear that the present invention offers an enormous range of possibilities. The heat radiation panel can be used for a large number of applications. Some of them have already been put forward here : double or triple glazing which can be used for the heat comfort of an interior environment, use in aquaria, and the fitting in a mirror. It is not, however, within the scope of this description to give an enumeration of all possible applications.

CLAIMS.

1. Transparent heat radiation panel based on glass, comprising one or more sheets of glass which are arranged parallel to each other and at least one glass surface of which is provided with a thin metal layer which is disposed in an electric circuit and is heated by the Joule effect, c h a r a c t e r i z e d i n t h a t the maximum temperature of said metal layer is between 20 and 70 deg.C, and is such that heat radiation is released at the external surfaces of the heat radiation panel.

2. Transparent heat radiation panel according to claim 1, c h a r a c t e r i z e d i n t h a t the power supplied on the metal layer is such that the temperature of the heat radiation panel is 45 degrees C.

3. Transparent heat radiation panel based on glass, comprising one or more sheets of glass which are arranged parallel to each other and at least one glass surface of which is provided with a thin metal layer which is disposed in an electric circuit and is heated by the Joule effect, c h a r a c t e r i z e d i n t h a t a second metal layer (5) is disposed between the heated metal layer (4) and one of the areas adjacent to the heat radiation panel.

4. Transparent heat radiation panel according to claim 3, comprising several sheets of glass arranged parallel to each other with a cavity between each of them, c h a r a c t e r i z e d i n t h a t the heated metal layer (4) is disposed on a glass surface facing a cavity, and the second metal layer (5) is disposed on another glass surface facing a cavity.

5. Transparent heat radiation panel according to claim 4 , comprising two glass sheets arranged parallel to each other with between them a cavity, or three

glass sheets arranged parallel to each other with between them two cavities, characterized in that the heated metal layer (4) is disposed on the one glass surface facing a cavity, and the second metal layer (5) is disposed on the other glass surface facing the same cavity.

6. Transparent heat radiation panel according to claim 5, characterized in that there is an additional electrically insulating screen (23) disposed between the two metal layers.

7. Transparent heat radiation panel according to claim 6, characterized in that the screen (23) is made of glass.

8. Transparent heat radiation panel according to claim 6 or 7, characterized in that the screen (23) is set up against the surface bearing the heated metal layer.

9. Transparent heat radiation panel based on glass, comprising one or more sheets of glass which are arranged parallel to each other and at least one glass surface of which is provided with a thin metal layer which is disposed in an electric circuit and is heated by the Joule effect, and with a contact strip along the length of the edges of its two opposite sides, characterized in that the contact strip consists of an adhesive tape (25) stuck onto the metal layer and made of an electrically conducting material.

10. Transparent heat radiation panel according to claim 9, characterized in that the contact strip further consists of a layer of metal (26) which on one or both sides of the adhesive tape (25) is diffused into the metal of both the adhesive tape (25) and of the metal layer (4) from the top surface of said adhesive tape (25) over the longitudinal edge

of said adhesive tape (25) and running out onto the metal layer (4).

11. Transparent heat radiation panel according to claim 10, characterized in that the metal layer (26) is based on silver.

12. Transparent heat radiation panel according to claim 9, 10 or 11, characterized in that an end of an electric cable (21) is soldered with a certain intermediate space onto the contact strip.

13. Transparent heat radiation panel according to claim 9, 10 or 11, characterized in that one edge of the adhesive tape is rolled round an electric cable (21) lying along said edge.

14. Transparent heat radiation panel based on glass, comprising one or more sheets of glass which are arranged parallel to each other and at least one glass surface of which is provided with a thin metal layer which is disposed in an electric circuit and is heated by the Joule effect, in which the various glass sheets are held apart by electrically conducting intermediate sections, which run along their edges and may be sealed with elastic sealing means, characterized in that at least the glass surface bearing the heated metal layer (4), and possibly also the other glass surfaces with a metal layer, along its edges at the height of the intermediate section (16) is provided with a strip (27) made of an electrically insulating material, running all the way round and stuck against the metal layer.

15. Transparent heat radiation panel according to claim 14, characterized in that the strip (27) is made of glass.

16. Double or triple insulating glazing for the separation of two environments, or mirror in which the heat radia-

tion panel according to one of claims 1 to 15 is incorporated.

17. Constructions and arrangements in which the heat radiation panel according to one of the preceding claims 1 to 16 is incorporated.

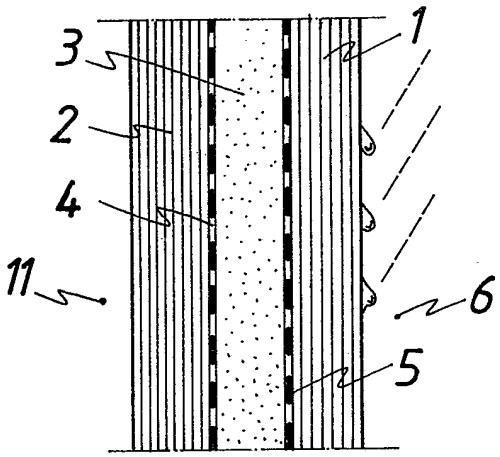


FIG. 1

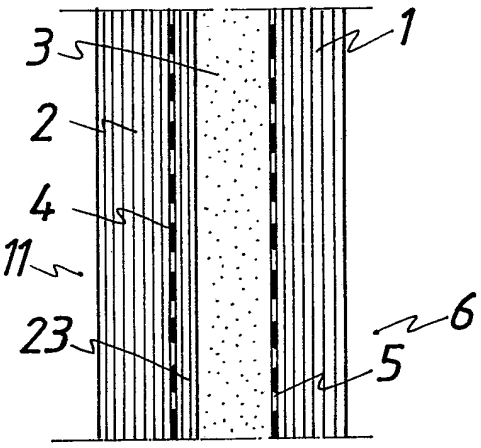


FIG. 2

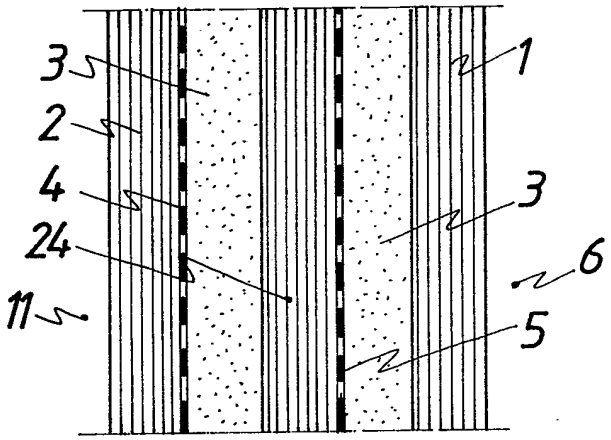


FIG. 3

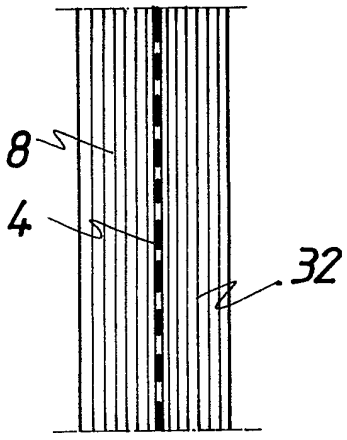


FIG. 4

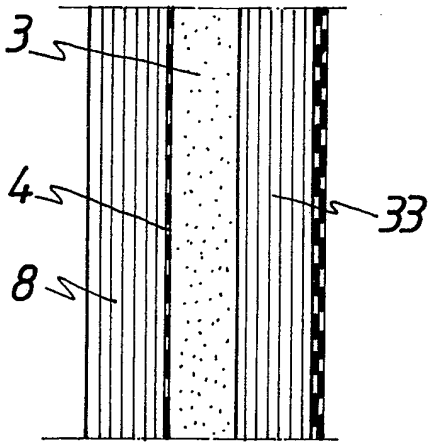


FIG. 5

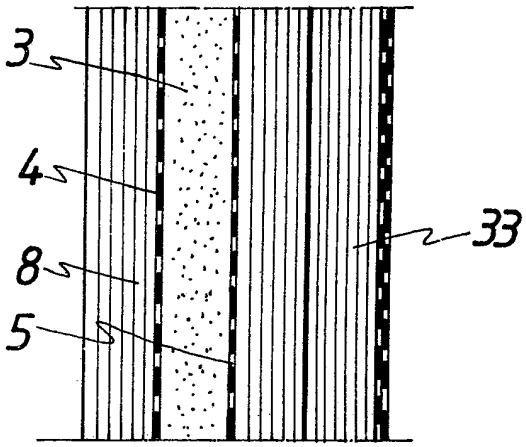


FIG. 6.

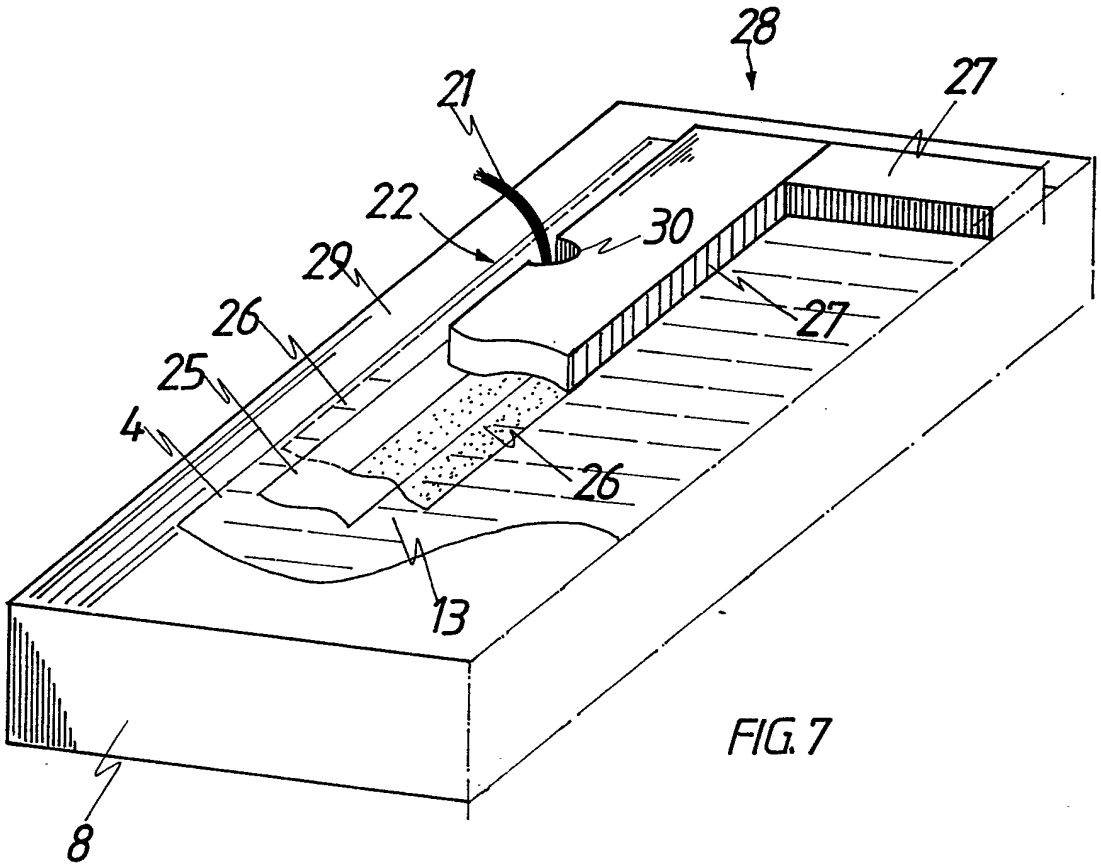


FIG. 7

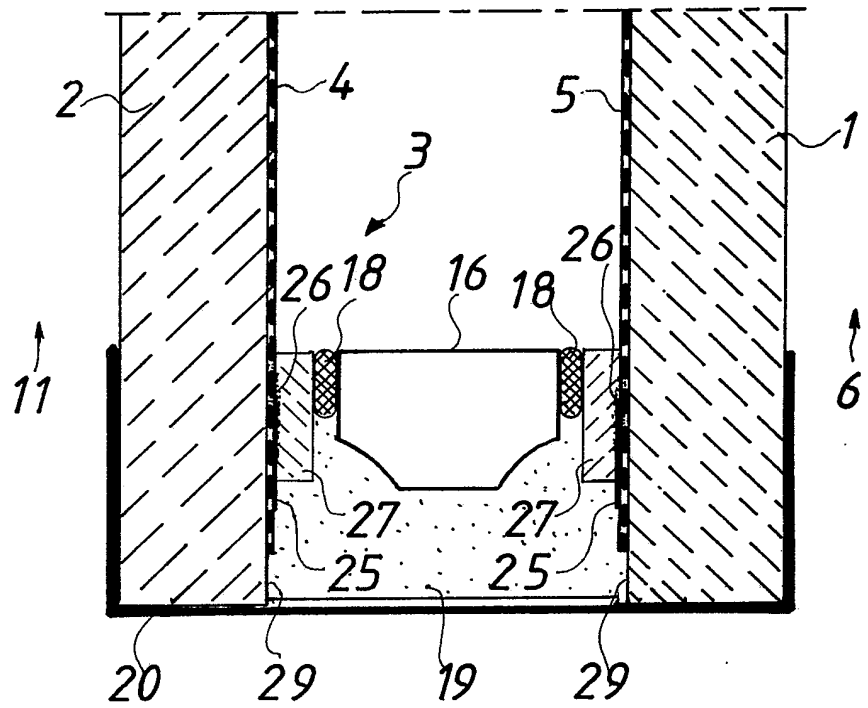


FIG.8

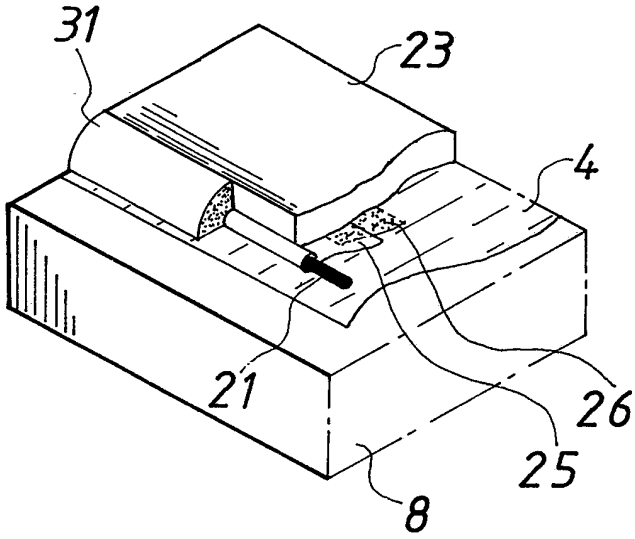


FIG.9